S P E C I F I C A T I O N

GLOW PLUG

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation in part of applicant's application Serial No. 10/309,607, filed December 3, 2002.

BACKGROUND OF THE INVENTION

The field of the invention is glow plugs and the invention relates more particularly to a high performance glow plug for use in state of the art engines, particularly in model car engines.

Internal combustion model cars have been refined to an extent that tethered model cars can substantially exceed 200 mph. In such extreme environments the glow plugs are heated to a temperature where conventional glow plugs will leak and fail. Various improvements in glow plug construction have been made. One such improvement is shown in U.S. Patent No. 6,346,688 having the same applicant as the present application. This patent is incorporated by reference herein.

Temperatures at the lower end of a glow plug can reach in excess of 1000°F. The combination of the pressure in the

cylinder of the engine and the high temperature of the lower end of the glow plug can result in the formation of leaks which reduce the compression within the cylinder which is highly detrimental to the performance of the engine. A better seal against leaking can result when the crimping downward force is increased. However, the amount of force is limited by the strength of the plug body. Increased crimping force can deform the base of the plug and cause it to deform outwardly. Various attempts at improving the crimping at the top of the glow plug have reduced, but not eliminated, the problem. A better seal against leaking can result when the crimping downward force is increased. However, the amount of force is limited by the strength of the plug body. Increased crimping force can form the base of the plug and cause it to move outwardly.

BRIEF SUMMARY OF THE INVENTION

It is an object of the present invention to provide a glow plug which can withstand state of the art high performance temperatures and pressures without leaking.

The present invention is for a glow plug construction which has a larger than a conventional base to spread the crimping force over a greater area, thereby reducing the force per unit of base area. The glow plug body has a circumferential groove

formed around the hexagonal portion of the body to permit the temporary attachment of an igniter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

Figure 1 is a cross-sectional view of the glow plug of the present invention prior to being crimped together taken along line 1-1 of Figure 4.

Figure 2 is a cross-sectional view of the glow plug of the present invention after crimping.

Figure 3 is an exploded perspective view of the glow plug of Figure 1.

Figure 4 is a side view of the plug of Figure 1.

Figure 5 is a side view of a plug of the prior art.

Figure 6 is a bottom view of the plug of Figure 4.

Figure 7 is a bottom view of the plug of Figure 5.

Figure 8 is a cross-sectional view taken along line 8-8 of Figure 4.

DETAILED DESCRIPTION OF THE INVENTION

A glow plug assembly prior to crimping is shown in Figure 1 and indicated generally by reference character 10. Glow plug 10 has a body 11 which has an outer shell portion 12, which surrounds an inner cavity 13. The base of body 11 has a threaded

portion 14, which would be screwed into an engine block in a conventional manner. Body 11 has a central axis 15 along which an inner electrode 16 is positioned.

Inner electrode 16 has a frusto-conical wall length 17, which extends upwardly from a base 18 to a washer 19. Washer 19 extends outwardly with respect to connector shaft 20. Washer 19 is preferably integrally formed with inner electrode 16.

Connector shaft 20 terminates in a connector for attachment to a source of electrical energy.

Inner electrode 16 is held centrally in body 11 by a pair of insulated rings. Insulating ring 22 is fabricated from an electrically non-conductive material. One such material is hard anodized aluminum. All surfaces of ring 22 are anodized so that it does not conduct any electricity between inner electrode 16 and body 11. Similarly, an upper washer 23 is electrically non-conductive. It may also be made from hard anodized aluminum. Washer 23 is part of a pressure-applying portion of the assembly of Figure 1. As shown in Figure 2, upper ring 24 may be crimped against a frusto-conical portion 25, which is at an angle of, for instance, 30° with respect to central axis 15. The result is a continuous downward pressure formed by the contact between the crimped upper ring 26 and the frusto-conical portion 25 of upper washer 23.

As shown in Figure 1, on initial assembly there is an upper gap 27 and a lower gap 28 between insulating ring 22 and washer 19 and lower floor 29, respectively. These gaps disappear during the crimping step as shown in Figure 2. Preferably, castor oil is applied between the outer frusto-conical surface 30 and the inner cavity 13, as well as between the inner frusto-conical surface 31 of ring 22 and the frusto-conical wall length 17. Also, a light oil, such as that sold under the trademark "W-D 40," is preferably applied to the outer surface of upper washer 23 to help lubricate the downward compression movement of the parts to provide a glow plug such as that shown in Figure 2. The glow plug in Figure 2 has no gaps between the upper and lower surfaces of ring 22.

The heating element 32 is welded between the base of inner electrode 16 and body 11. The outer body is preferably fabricated from steel and the upper ring thereof 24 is moved inwardly by a crimping tool 33, which has a frusto-conical wall portion 34, and a connector opening 35. A downward pressure of 2500 to about 3000 pounds is preferably exerted, as shown in Figure 2, which squeezes the inner electrode and the insulating ring downwardly until there is no significant gap above and below insulating ring 22, as shown in Figure 2.

The frusto-conical angles relating to insulating ring 22 should be small enough so that they provide a locking taper. That is, when pressure is exerted downwardly on ring 22 in cavity 13, the angle is small enough so that the ring is locked into the cavity rather than simply falling out. This angle should be between 6° and 12°, and preferably about 8°. The presence of lubricant 36 and 37 helps to facilitate the elimination of gaps 27 and 28 during the crimping step. Also, it is believed that the use of castor oil at the area indicated by reference character 36 is further beneficial to prevent the escape of gases between ring 22 and either the body or the inner electrode. Castor oil, when sufficiently heated, will form a gummy residue which is believed to further enhance the sealing effect of the assembly under high temperatures.

As can be seen in the prospective view of Figure 3, glow plug 10 has a hexagonal portion 38 which extends from an upper end 39 to a base 40. The hexagonal portion is interrupted by a circumferential groove 41. Threaded portion 14 extends downwardly from base 40. Glow plug 13, after crimping is shown in side view in Figure 4. A prior art glow plug 42 is shown in side view in Figure 5. Glow plug 42 also has a hexagonal portion 43 and has a decorative circumferential groove 44. There is a substantial difference between grooves 41 and 44. As is visible

from comparing Figures 4 and 5, circumferential groove 41 extends completely around the hexagonal portion. For instance, by viewing Figure 8, it can be seen that groove 41 has a depth "d" in the middle of the hexagonal face in which it is located. In contrast, groove 44 shown in Figure 5 has no depth at all in the center portion of the hexagonal faces. This groove 41 permits the attachment of an igniter. For a glow plug having a 5/16" hex, a groove having an inside diameter of 0.275" provides an appropriate depth for affixing of an igniter.

Hexagonal portion 43 extends from an upper end 45 to a lower end 46. A lower cylindrical portion 47 extends from lower end 46 to base 48. This forms a shelf 49 adjacent lower end 46. When the top of the plug is crimped, a downward force is exerted on the crimped portion of the plug, as shown in Figure 2 of the drawings. An analogous force is placed on crimp 50 of plug 42. If the force reaches a sufficient level, base 48 is forced outwardly, as indicated by phantom line 51. This distortion prevents the exertion of additional force on crimp 50 and can limit the effectiveness of the sealing of the elements of the plug into a leak-free assembly.

In order to decrease the tendency of the deformation indicated by phantom line 51, the area of the base has been increased, as shown best by comparing Figure 6 with Figure 7. In

Figure 6, the area for support of the plug during crimping is cross-hatched in Figure 6 and exists essentially from the outer hexagonal portion 38 to the inner threaded portion 14. This cross-hatched area 48 is less than half of the area 40 shown in Figure 6. It is, therefore, possible to exert a far greater crimping force without any distortion of the base of the plug. The present embodiments of this invention are thus to be considered in all respects as illustrative and not restrictive; the scope of the invention being indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.